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Proposed Topic of Research

Design of an Ultra Wideband Antenna with WLAN Rejection for Wireless Communication

Objectives of the Proposed Research:

1. The main Objective is to design a suitable or optimal Ultra wide band antenna.
2. The first important requirement for designing an UWB antenna is the extremely wide impedance bandwidth. Bandwidth of 7.5GHz is required for a workable UWB antenna.
3. The return loss for the entire ultra-wide band should be in the range of less than -10dB
4. The radiation efficiency is required to be quite high.
5. Low directivity is desired .
6. The gain should be as uniform as possible for different directions

Background of the Proposed research

Introduction:

The Federal Communications Commission (FCC) approved the frequency band in the range of 3.1 to 10.6 GHz in 2002[1]. This motivated both academic and industrial communities to develop compact antennas for UWB applications. The UWB technology gives high-speed data transmission rate with low power consumption. The applications of Ultra Wideband antenna are in wireless communications, medical imaging, radar and indoor positioning. The

merits of printed antenna such as light weight, small size and low profile make them an attractive for UWB antenna development. A conventional microstrip antenna has drawback of narrow impedance bandwidth [2].

In February 14, 2002, the Federal Communications Commission (FCC) amended the Part 15 rules which govern unlicensed radio devices to include the operation of UWB devices[3]. The FCC also allocated a bandwidth of 7.5GHz, i.e. from 3.1GHz to 10.6GHz to UWB applications [1], is a revolutionary approach for short-range high-bandwidth wireless communication. Differing from traditional narrow band radio systems (with a bandwidth usually less than 10% of the centre frequency) transmitting signals by modulating the amplitude, frequency or phase of the sinusoidal waveforms, UWB systems transmit information by generating radio energy at specific time instants in the form of very short pulses thus occupying very large bandwidth[3] .

Due to the transmission of very short pulses, UWB radio propagation will provide very high data rate which may be up to several hundred Megabytes per second, and it is difficult to track the transmitting data, which highly ensures the data security. For the same reason, the transmitting power consumption of UWB systems is extremely low in comparison with that of traditional narrowband radio systems. UWB technology is widely employed in many applications such as indoor positioning, radar/medical imaging and target sensor data collection.

One of the challenges for the implementation of UWB systems is the development of a suitable or optimal antenna. The first important requirement for designing an UWB antenna is the extremely wide impedance bandwidth. Bandwidth of 7.5GHz is required for a workable UWB antenna. And commonly, the return loss for the entire ultra-wide band should be in the criterion of less than -10dB [3]. Next, for indoor wireless communication, omnidirectional property in radiation pattern is demanded for UWB antenna. Therefore, low directivity is desired and the gain should be as uniform as possible for different directions [4].

Another important requirement is the radiation efficiency. Since the power transmitted into space is very low, the radiation efficiency is required to be quite high (normally the radiation efficiency should not be less than 70%). Last but not least, UWB technology is mainly employed for indoor and portable devices, the size of the UWB antennas is required to be sufficiently small so that they can be easily integrated into various equipments. Extensive investigations are carried out on the development of UWB antennas from the past to present [5].

Literature Review of Research Topic:

The micro-strip antenna is "an antenna that consists of thin metallic conductor bonded to a thin grounded dielectric substrate" [2]. The radiation of micro-strip antenna is based on the discontinuities of the antenna element. The radiation characteristics of a rectangle micro-strip antenna can be estimated from the field distribution of the patch.

A Micro-strip patch antenna is very simple in construction as shown in figure 1. Most commonly used Micro-strip patch antennas are rectangular and circular patch antennas. These patch antennas are used in simple, as well as widest and most demanding applications.

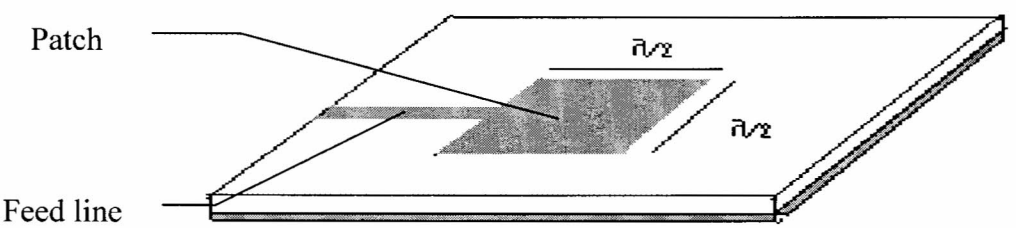

Fig. 1 - An edge-fed patch antenna

Micro-strip antennas have some merits and some de-merits.

Merits:

- Low weight, low volume and thin profile.

- Low fabrication cost, easily mass producible.

- Linear and circular polarizations are possible.

- Easily integrated with microwave integrated circuits.

- Capable of dual and triple frequency operations.

- Feed lines and matching networks can be fabricated simultaneously.

De Merits:

Micro-strip antennas have some demerits:

- Low efficiency.

- Low Gain.

- Low power handling capacity.

- Excitation of surface waves.

- Polarization purity is difficult to achieve.

- Complex feed structures require high performance arrays.

- Unacceptably high levels of cross polarization and mutual coupling within the array environment at high frequencies.

***Types of Micro-strip Antennas*:**

There are different types of Micro-strip antennas which are classified based on their physical parameters. These different types of antennas have many shapes and dimensions. Micro-strip antennas can be classified into four groups:

- Micro-strip patch antennas

- Micro-strip dipoles

- Printed slot antennas

- Micro-strip traveling wave antennas

Micro-strip Patch antennas: -

A Micro-strip patch antenna is a thin conducting patch of any shape and size on one side of a dielectric substrate, the other side having a ground plane. Several feeding mechanism can be used for the micro-strip antenna and they offer the designer many parameters to optimize the antenna performance. Flexibility of the micro-strip antenna configurations was the main reason why these structures were chosen to be designed[2].

The patch in the antenna is made of a conducting material Cu (Copper) or Au (Gold) and this can be of any shape Fig 2 as rectangular, circular, triangular, elliptical or some other shape [2] as shown below.

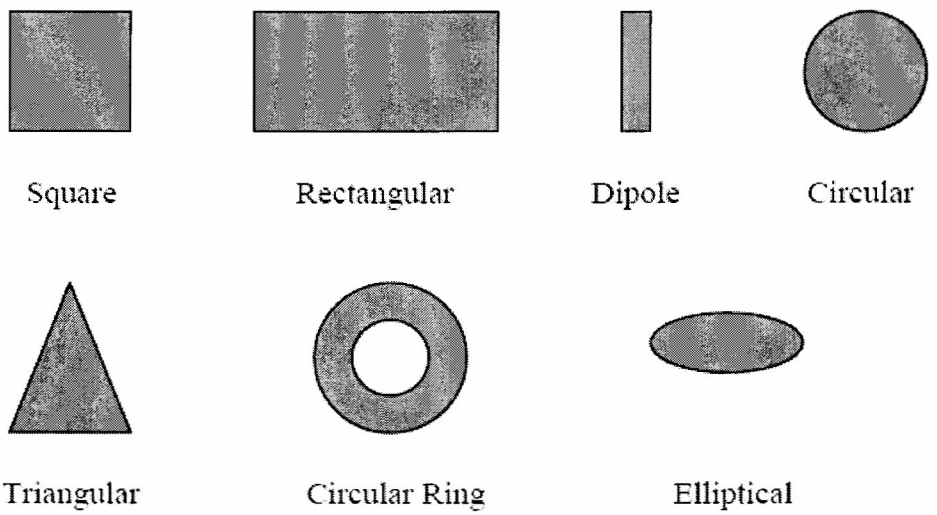

Figure 2: Common shapes of the patch antennas which are in use [2].

The basic antenna element is a thin conductor of length L and width W. It is deposited on a dielectric substrate with dielectric constant ε_r, height h and a ground plane. The rectangular patch antenna is designed so that it can operate at the specified resonance frequency [2]. The length for the patch does depend on the height of the dielectric substrate. The length of the patch normally would be $0.333\lambda < L < 0.5\ \lambda$, where λ is the free space wavelength.

The physical length of the patch can be calculated by the simple formula from [2]

$$L_{eff} = L + 2\Delta L$$

L_{eff} = Effective length of the patch

L = Physical length of the patch

ΔL = Extension of length of the patch due to fringing fields

The height *h* of the dielectric substrate that supports the patch usually ranges between $0.003\ \lambda < h < 0.05\lambda$ Value of dielectric constant (ε_r) of the substrate is usually between 2.19 and 12.

The patch of the antenna is excited by feed which may be edge feed or a probe feed. When the patch is excited by feed, a charge distribution is established between the ground plane and the underneath of the patch. The underneath of the patch is charged positive and the ground plane is charged negative after excitation. The attractive forces are setup between the planes i.e., patch underneath and the ground plane.

These patch antennas are narrow band devices with a bandwidth ~ 10% of λ, and also having poor radiation efficiency. A good performance from the patch antenna can be expected with a thick dielectric substrate of low dielectric constant as this gives better efficiency, larger bandwidth and better radiation [13]. But these types of antennas are larger in size.

Feed Techniques and Modeling of Micro-strip Antennas:-

Micro-strip patch antenna has various feeding techniques.

1. Micro-strip line

2. Coaxial probe

3. Aperture coupling

4. Proximity coupling

Design process of micro-strip antenna:-

There is no universal mathematical method to determine the geometry of an antenna based on specific requirements and the design process of the antennas is done through analysis an antenna geometry is constructed and parameters are calculated for that structure. Then dimensions of the antenna are altered until the desired properties are achieved. The transmission and cavity model are used to analyze micro-strip antennas [2].

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Gap in Existing Research

Interference is a serious problem for UWB application systems. UWB having a bandwidth of 7.5GHz i.e. from 3.1GHz to 10.6GHz.UWB applications requires the rejection of the interference with existing wireless local area network (WLAN) technologies such as IEEE 802.11a in the USA (5.15-5.35GHz, 5.725-5.825GHz). So that UWB transmitters can not cause any electro-magnetic interference on nearby communication systems such as Wireless LAN (WLAN) applications.

Methodology:-

Following steps are implemented:-

Phase1: Literature Survey

A detailed literature survey will be carried out to understand the theory of ultrawide band antenna, it is necessary to be equipped with the basic knowledge of microstrip antenna. Since the ultrawide band antenna having band of 7.5GHz. UWB technology is widely employed in many applications such as indoor positioning, radar/medical imaging and target sensor data collection.

Continuous literature survey will be carried out to collect the information required during various stages of the proposed research. The source of this literature survey will be various available journals like, IEEE, IETE, Journal of wireless communication, e-books, internet sites and e-journals source .

Phase 2: Designing of uwb antenna

An Ultrawide band antenna will be designed for operation from 3.1GHz to10.6 GHz. Standard formulae and standard design procedure will be used for drawing the 3D structure of basic antenna.

HFSS software will be used to construct the 3D model and to simulate antenna characteristics.

Phase 3: Designing of an uwb antenna with band notch

An Ultrawide band antenna will be designed for operation from 3.1GHz to10.6 GHz. With band notched characteristic by cutting slots in the patch to reject the band from 5.1GHz to 5.8 GHz which is for WLAN.

Phase 4: Analysis of Results

All the graphs will be drawn like return loss, VSWR, smith chart, radiation patterns and all the results will be verified with standard requirement.

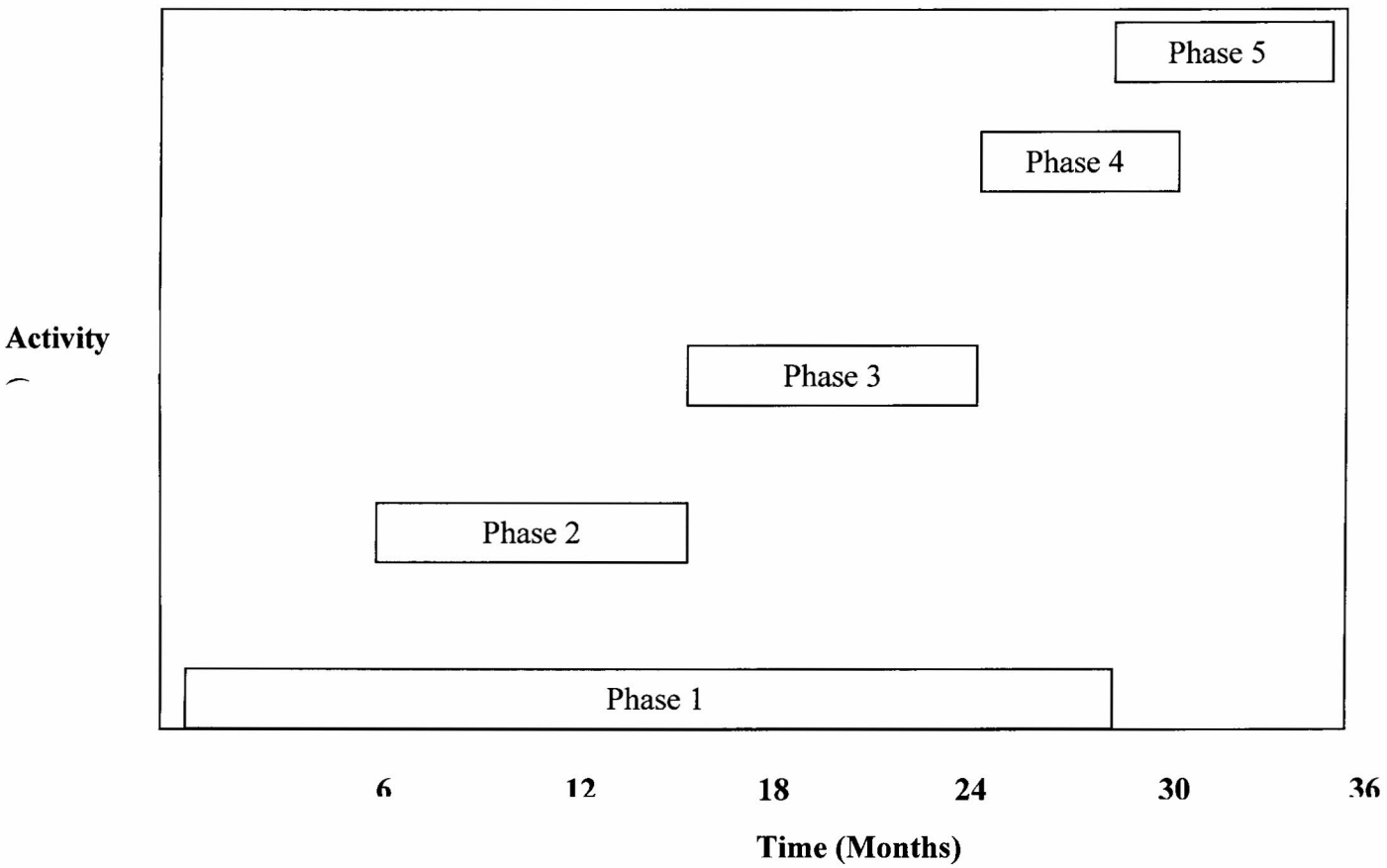
Phase 5: Conclusion and Thesis writing

In this phase, all the experimental and theoretical work carried out in different phases will be documented in the form of thesis.

Work Plan

The work-plan for the above-mentioned seven activities is shown in figure.

Figure: WORK PLAN



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